We claim:

1. A high temperature/high pressure (HP/HT) apparatus, which comprises:

(a) a pressure vessel comprising a cell for growing crystals or processing material in a liquid or solid pressure transmitting medium;

(b) at least a heating element for heating said cell;

(c) at least an electrical power system for powering said heating element;

(g) at least an electrical insulator disposed within said pressure vessel for establishing at least two different electrical heating paths are between said heating element and said electrical power system for independently controlling the temperatures of at least two locations in the cell.

2. A high temperature/high pressure (HP/HT) apparatus for growing crystals or processing material in a liquid or solid pressure transmitting medium in a cell, wherein the temperature difference between two locations within the cell may be adjusted to a minimum below 15 °C and a maximum greater than 25 °C while the cell is being heated to a growth temperature of between 500 °C and 1300 °C.

3. A gallium nitride single crystal grown in the HP/HT apparatus of claim 1, wherein said gallium nitride single crystal has a dislocation density of less than 10^4 per cm^2.

4. The HP/HT apparatus of claim 1, wherein the cell comprises at least a temperature sensor for measuring the temperature of at least a location in the cell, and wherein the temperature sensor is selected from one of a thermocouple, a thermistor, an optical fiber coupled to an optical pyrometer, or any combination thereof.

5. The HP/HT apparatus of claim 1, wherein

said cell comprises a lateral confining die and at least an upper and lower pressure anvils,

the heating element comprises a cylindrical heating element having at least one end in electrical contact with at least one of the anvils;

at least one of the anvils or die is in electrical contact with a central portion of the heating element.

6. The HP/HT apparatus of claim 1, wherein

said apparatus further comprises nested elements within said at least one anvil, with an electrical insulator separating the nested anvil elements;

said cell is defined by a lateral confining die and at least an upper and lower pressure anvils, at least one of which comprises a nested anvil element;

the heating element comprises at least two nested cylindrical heating elements each having at least two ends, and wherein at least one of said elements hasa non-uniform cross section;

the first end of each cylindrical heating element being in electrical contact with at least one of the anvils or the nested anvil elements, and the second end of each of the cylindrical heating elements being in separate electrical contact with a different anvil or nested anvil element.

7. The HP/HT apparatus of claim 1, wherein

said apparatus further comprises an upper and a lower pressure anvil;

said cell is defined by at least two lateral confining dies having at least two components electrically separated from one another by at least one insulator,

at least a portion of the heating element is in electrical contact with at least one of the dies and at least another portion of the heating element is in electrical contact with at least one of said anvils.

8. The HP/HT apparatus of claim 1, wherein the pressure vessel is selected from one of a belt apparatus, a zero-stroke apparatus, a piston-cylinder apparatus, a multi-anvil press, a split-sphere apparatus, and a toroid apparatus.

9. The HP/HT apparatus of claim 7, wherein the pressure vessel comprises a toroid apparatus having upper and lower recessed anvils in electrical contact with opposite ends of the heating element, and with at least one disk element between the recessed anvils in electrical contact with at least one portion of the heating element, and further comprises insulators separating the disk elements from one another and from the upper and lower anvils.

10. The HP/HT apparatus of claim 1, wherein the heating element is formed from at least one of graphite foil, graphite, a Ni (60%)/Fe (25%)/Cr (15%) alloy, niobium, titanium, tantalum, stainless steel, nickel, chromium, zirconium, molybdenum, tungsten, rhenium, hafnium, platinum, silicon carbide, and combinations thereof.

11. The HP/HT apparatus of claim 1, wherein the pressure transmission medium comprises one or more of alkali metal halide, talc, pyrophyllite, molybdenum disulfide, graphite, hexagonal boron nitride, silver chloride, calcium fluoride, strontium fluoride,

calcium carbonate, magnesium oxide, zirconium oxide, merylinite clay, bentonite clay, sodium silicate, and combinations thereof.

12. The improved HP/HT apparatus of claim 1, which is capable of growing crystals at pressures ranging from between about 2 kbar and about 100 kbar.

13. The HP/HT apparatus of claim 1, wherein said heating element is selected from at least one of a heating tube, a heated foil, a ribbon, a bar, a wire, a ring, or combinations thereof.

14. A method for treating a sample in a liquid or solid pressure transmitting medium using a high temperature/high pressure (HP/HT) apparatus, which method comprises the steps of:

placing the sample in the HP/HT apparatus which comprises a pressure vessel having a cell disposed in said pressure vessel, a heating element for heating said cell, an electrical power system for powering said heating element; at least an electrical insulator disposed within said pressure vessel for establishing at least two different electrical heating paths between said heating element and said electrical power system for independently controlling the temperatures of at least two locations in the cell;

processing of said sample by subjecting said sample to conditions of high pressure and high temperature, wherein the temperature is independently controlled for at least two different locations within the cell.

15. The method of claim 14, wherein the cell comprises at least a temperature sensor for measuring the temperature of at least a location in the cell and wherein the temperature sensor is selected from one of a thermocouple, a thermistor, an optical fiber coupled to an optical pyrometer, or any combination thereof.

16. The method of claim 14, wherein

said cell is defined by a lateral confining die and at least an upper and lower pressure anvils,

the heating element comprises a cylindrical heating element having at least one end in electrical contact with at least one of the anvils;

at least one of the anvils or die is in electrical contact with a central portion of the heating element.

17. The method of claim 14, wherein

said apparatus further comprises nested elements within said at least one anvil, with an electrical insulator separating the nested anvil elements;

said cell is defined by a lateral confining die and at least an upper and lower pressure anvils, at least one of which comprises a nested anvil element

the heating element comprises at least two nested cylindrical heating elements each having at least two ends, and wherein at least one of said elements hasa non-uniform cross section;

the first end of each cylindrical heating element being in electrical contact with at least one of the anvils or the nested anvil elements, and the second end of each of the cylindrical heating elements being in separate electrical contact with a different anvil or nested anvil element.

18. The method of claim 14, wherein

said HP/HT apparatus further comprises an upper and a lower pressure anvils;

said cell is defined by at least two lateral confining dies having at least two components electrically separated from one another by at least one insulator,

at least a portion of the heating element is in electrical contact with at least one of the dies and at least another portion of the heating element is in electrical contact with at least one of said anvils.

19. The method of claim 14, wherein the pressure vessel is selected from one of a belt apparatus, a zero-stroke apparatus, a piston-cylinder apparatus, a multi-anvil press, a split-sphere apparatus, and a toroid apparatus.

20. The method of claim 19, wherein the pressure vessel comprises a toroid apparatus having upper and lower recessed anvils in electrical contact with opposite ends of the heating element, and with at least one disk element between the recessed anvils in electrical contact with at least one additional portion of the heating element, and with insulators separating the disk elements from one another and from the upper and lower anvils.

21. The method of claim 14, wherein the heating element is formed from one or more of graphite, a Ni (60%)/Fe (25%)/Cr (15%) alloy, niobium, titanium, tantalum, stainless steel, nickel, chromium, zirconium, molybdenum, tungsten, rhenium, hafnium, platinum, or silicon carbide.

22. The method of claim 14, wherein the pressure transmission medium comprises one or more of alkali metal halide, talc, pyrophyllite, molybdenum disulfide, graphite, hexagonal boron nitride, silver chloride, calcium fluoride, strontium fluoride, calcium carbonate, magnesium oxide, zirconium oxide, merylinite clay, bentonite clay, or sodium silicate.

23. The method of claim 14, wherein said processing comprises growing crystals from said sample at pressures ranging from between about 2 kbar and about 100 kbar.

24. The method of claim 18, wherein said heating element is selected from at least one of a heating tube, a heated foil, a ribbon, a bar, a wire, a ring, or combinations thereof.

25. A high temperature/high pressure (HP/HT) apparatus, which comprises:

(a) a pressure vessel comprising a cell for growing crystals or processing material in a liquid or solid pressure transmitting medium;;

(b) at least a heating element for heating said cell;

(c) at least an electrical power system for powering said heating element;

(e) at least a cooling circuit disposed within said pressure vessel for independently controlling the temperatures of at least two locations in the cell.

26. The HP/HT apparatus of claim 25, wherein

said cell is defined by a lateral confining die and at least an upper anvil and a lower pressure anvil;

wherein said cooling circuit is associated with said lateral confining die and at least one anvil.

27. A gallium nitride crystals grown by the method of claim 14, wherein said crystal has a dislocation density of less than 10^4 per cm^2